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*Foods of a Similar Nature
NOT supplying
Vitamin-A.*

Vegetable Oils, such as
Olive, Almond, Linseed
and Cotton Seed Oil.

Nut Butters.

Margarine made from
Vegetable Fat.

Lard.

Pork and Bacon Fat.

*Similar Nature
supplying
Vitamin-B.*

Butter, Egg Yolk and Bread,
Macaroni, etc.

Liver, with it.

Butter, etc.

Milk, etc.

Fatty Fish.

Meat, etc.

Green Vegetables.

Carrots, etc.

Tomatoes, etc.

Margarine, etc.

Butter, etc.

Wholemeal Bread.

*Foods of a Similar Nature
NOT supplying
Vitamin-C.*

Dried Fruits, such as Figs,
Prunes, Dates, Currants
Raisins, Sultanas, etc
Tinned and Bottled Fruits
and Vegetables.

Greens *cooked with soda*
Fruit or Vegetables *cooked
for a long time, or twice
cooked.*

Jam, Marmalade
Artificial Fruit Jellies.
Milk, *heated twice.*
Milk, + *sodium citrate.*
White Turnips, Beetroots
Grapes, contain little or
no Vitamin-C.

*Those not supplying
"Protein"*

Vegetables,
Pulses
some Protein,
but of "good"
quality.

no Protein in
and Sugars.

* = contains

A healthy diet consists of five squares

FOOD AND HEALTH

BY

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AND

VIOLET G. PLIMMER

*WITH COLOURED FRONTISPICE
AND DIAGRAMS IN THE TEXT*

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BY THE SAME AUTHOR

VITAMINS AND THE
CHOICE OF FOOD

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Preface

THIS small book is an attempt to explain concisely the principles which should guide the selection of food and to point out which foods should be eaten and why others should be avoided. It has developed out of several other short accounts which we have written and in response to a demand for a shorter version of our book on *Vitamins and the Choice of Food*, which gives the history of the discovery of the vitamins and the experimental work in greater detail. The subject matter was arranged for a series of lectures promoted by Miss Olga Nethersole, R.R.C., Founder and Honorary Organiser of the People's League of Health, and a desire was expressed for their publication.

Scientific and technical terms cannot be entirely avoided, but they are very few in number and are not too difficult for the general reader. Complaints have been made in the daily press that such words as *vitamin* or *protein* are too complicated and that scientific people cannot express themselves in simple language. The complaint should really be on the other side, that the public and the press do not trouble to learn a few special terms relating to food, though they pick up without effort a large number of technical terms dealing with wireless, motor cars, athletics and dress.

The diagram of "A Square Meal" was first published in the pamphlet, *What we should eat and why*, written for the People's League of Health. The idea was developed and used in an article in *The Practitioner*, January, 1925, to demonstrate the errors in the common every day diet. These diagrams are again made use of here in a slightly different form.

R. H. A. P.

March, 1925.

V. G. P.

Messrs. Longmans & Co. are indebted to the proprietors of *The Practitioner* for their courtesy in allowing these diagrams to be re-drawn for this book.

CHAPTER I

CIVILISATION AND THE CHANGES IT HAS MADE IN OUR FOOD

FOOD has gradually undergone great changes since those primitive days when man subsisted precariously like a wild animal upon fruits, seeds and roots, varied occasionally by a lucky find of honey or eggs, or by the trapping of fish and small animals. As his ingenuity and skill in making weapons developed, he was able to kill larger animals. At first all food was eaten raw, but later, he learned how to make fire to warm himself and discovered that some foods, if cooked, were more palatable. With the help of simple tools he began to till the ground and sowed the seeds of his favourite food plants. Man was thus no longer dependent upon chance but could lay up stores of grain until the next seed-time. Instead of relying upon the uncertainty of hunting for his supply of meat, he tamed and bred animals and birds to provide meat, milk and eggs. When his crops had exhausted the land, he removed with his flocks and herds to cultivate another part.

In this way man's food supply became more assured, but in Northern climates, such as our own, the winter was a difficult time, especially after a bad harvest. There was not enough pasture for the flocks during the cold months, so that the number of beasts had to be limited and only a few of the best stock were kept for breeding purposes. In the autumn most of the animals were killed and their flesh was salted or smoked and dried for winter use. The people did not thrive upon their salted and dried rations and there was much scurvy in the Middle Ages, especially in London, so it was sometimes called "the London disease." The nobility and Lords of the Manor had their dovecots and game preserves to provide themselves with fresh animal food during the winter.

As our sailing ships made longer voyages, occasional raids and exploratory expeditions gave place to regular over-seas trade, which led to changes in the home food supply. New customs were introduced from abroad. Foodstuffs grown in warmer climates were imported and foreign plants were brought home and successfully cultivated. The custom of eating green salads was introduced by Catherine of Aragon, wife of Henry VIII. She had to import a Dutch gardener, as salad-growing was an unknown art in this country and up to the present day green salads have never been as popular here as they are on the continent.

It is common knowledge that Sir Walter Raleigh brought home the potato plant in Elizabethan times, but it was some centuries before potatoes were extensively used for human food. They were looked upon as pig food and were only eaten by people who were destitute.

The cultivation of oranges was introduced into the Mediterranean countries by the Portuguese in the sixteenth century. This attractive fruit was soon after brought to England and made a valuable addition to the monotonous winter fare.

The planting of root crops, such as the turnip, dates in this country from the middle of the seventeenth century. This was an important innovation, as large numbers of animals could now be fed through the winter on turnips and hay and it was no longer necessary to kill off most of the animals in the autumn. More livestock was kept and consequently more meat was eaten.

From the middle of the seventeenth to the middle of the nineteenth century, it may be said that the quality of the food in this country was at its best. Agriculture had so far advanced that there was a good supply of home-grown food, pleasantly varied by the importation from abroad of spices, nuts and fruits like the orange and lemon. Most of the food eaten was fresh and free from the baneful influences imposed later by our mechanical, chemical age. The perfect spacing and freedom from decay in the teeth of our ancestors of this period testify to the satisfactory nature of their food and is in marked contrast with the teeth of the present generation which are overcrowded and begin to decay very quickly.

The nineteenth century saw great changes in the kind of foodstuffs used in most parts of the world. These changes

took place so gradually and insidiously that elderly people seem quite unaware of the alteration in the food which has taken place during their lifetime. They cannot understand the present agitation about our food and say, "We never worried about vitamins when we were young and we did very well without them." They do not realise that they did so well because they were fed upon relatively natural foodstuffs which had not had their vital elements removed or destroyed by commercial processes. Babies were not then reared on bottles ; they were suckled by their mother or a wet nurse.

Not so very long ago sugar was a rare luxury kept under lock and key in the tea caddy. At the end of the eighteenth century the manufacture of beet sugar was begun in Germany and the industry developed rapidly and lowered the price of sugar. Its consumption has increased enormously and is still increasing in all civilised countries. The Americans, with their love of candy, are the largest sugar eaters in the world. Incidentally, cancer and diabetes, two scourges of civilisation, have increased proportionately to the sugar consumption.

The sugar factory was the thin end of the wedge. Previously food and factories had had nothing to do with each other, but now many artificial processes have been interposed between man and the plants and animals from which his food is derived. A modern provision shop is filled with packets and tins branded by a factory. *We do not know what has been added to or taken away from our food.* Mummi-fied preparations are vividly dyed to simulate the green freshness of plants, the red or yellow of fruit juices, the golden colour of butter and eggs.

Cereal foods have suffered most severely since the introduction of machine-milling about 1870. Formerly the staple cereal of the East, rice, was pounded by hand and in this country our wheat was coarsely stone-ground at the local mill and only part of its bran removed. Wellington's soldiers were famous for their fine figures and good looks, yet the food they ate would be scorned now-a-days. They received one pound of wheat per day. They ate the whole grain as it was issued, or if time allowed they pounded it up and made a coarse bread. They were allowed a few ounces of whole-

meal flour weekly. During the Peninsular war they were dependent for their meat supply upon any goats they might chance to catch in the mountains. What a contrast to the white flour and tinned meat and vegetable ration of modern armies on active service!

The modern machine-mill with its steel rollers removes all the bran and germ from the grain so that we eat only the innutritious core of the seeds of wheat, rice, barley and maize. Owing to a difference in the structure of the seeds, rye and oatmeal suffer less damage.

During the nineteenth century our population increased greatly and following the invention of machinery we became a manufacturing people living in towns instead of an agricultural people producing its own food. At the beginning of the century the corn was home-grown, at the end of the century most of the corn and other foodstuffs came from abroad. Many changes in the nature of our food have arisen from the impracticability of importing perishable materials from the other side of the world. White cereals and sugar travel well, and fruits are carried without risk of going bad, if bottled, canned, dried or preserved as jam. For the same reason, meat, fish, vegetables and milk are canned or dried. Some foodstuffs are preserved by chemicals, others come over in cold storage. These chilled foodstuffs more closely resemble the fresh material in nutritive value, if they are not kept indefinitely in cold store.

Towards the end of the last century uneasiness was caused by the discovery of bacteria and the manner in which infectious diseases were carried. We felt ourselves exposed on all sides to the attack of malevolent germs and parasites. The most easy entrance of bacteria into the body was obviously with our food, and we were cautioned against eating any raw foods, such as oysters, salad or fruit. The whiteness of our cereal foods received an added glamour as whiteness typified cleanliness and freedom from germs. Brown cereals were looked upon with suspicion. The pasteurisation of the milk supply in towns lowered the infant death rate from summer diarrhoea and the sterilisation of foodstuffs at first sight appeared to be a means of escape from many illnesses.

During the last twenty-five years the subject of food and nutrition has been most carefully investigated, not only by

the bacteriologist but particularly by the physiologist and bio-chemist. Formerly it was chiefly a matter of opinion which foods were good and nourishing and which were indigestible or harmful. No exact data were available. The choice of food was, and still is, governed mainly by convenience and individual tastes. The subject of nutrition is now a science based upon ascertained facts and measurements. The knowledge gained by scientific research is available for general use and although it is by no means complete, yet enough facts are known to afford a reliable guide to the choice of proper food. Feeding experiments have shown that in man and animals, the perfect growth of the body and its resistance to disease depend more largely upon food than on any other hygienic factor. A well-nourished body is a good protection against infection by germs, or by larger parasites like intestinal worms. The sterilisation of foodstuffs has been found to destroy a great deal of their nutritive value.

Civilised man has no instinct for choosing the right kind of food ; his likes and dislikes are not a reliable guide amongst the overwhelming abundance of artificial products which are offered to him. If we want to find races with splendid physique and health, we must look in those out-of-the-way corners of the world where geographical isolation or religious restrictions have caused the natives to adhere to the primitive diet of their forefathers—wholemeal flour, seeds, fruits and vegetables, often eaten raw with a good deal of milk and butter and little or no meat. On this diet they are healthy and live to an active old age. They do not suffer from the diseases of civilisation—constipation, indigestion, gastric and duodenal ulcers, gall stones, appendicitis, colitis, rheumatism, cancer and diabetes—although they live under very insanitary conditions and may be exposed to damp and extremes of heat or cold. European settlers amongst these natives are much better housed and washed, but suffer from the diseases enumerated above and die with tragic frequency from cancer. Doctors, who have worked for many years in such districts, have concluded that the good condition of the natives and the diseased state of the Europeans can only be explained by the difference in their food. The Europeans are not content with the native food grown locally

but import white cereals, tinned foods and sugar. If the natives adopt the same diet as the Europeans, they suffer from the same diseases and no longer have perfect teeth.

Now-a-days our cattle, sheep and poultry are fed upon sophisticated food-stuffs and it has been proved that the nutritive value of the milk and fat from these animals is nothing like as good as that from animals at grass or allowed free range. Even our fields receive artificial manures and it may well be that the grass and corn raised on chemical manures will prove to be less nourishing than those from naturally manured fields. An investigation by Col. R. McCarrison, I.M.S., in this connection showed the superiority of "natural" over "artificial" manures in influencing the nutritive and vitamin-B value of food grains.

Machines and chemicals have brought us into a dangerous position as regards our food supply, but as we now realise our predicament it should not be a difficult matter to rectify our mistakes.

CHAPTER II

FOOD : ITS PURPOSE AND NATURE

FOOD has two distinct purposes. The greater part is burned up to keep the body warm and give it energy for movement, and never becomes part of the living tissues. It is burned like the coal in the fire of the steam engine. The harder the work, the more fuel or food is wanted. The foodstuffs which are burned up to give warmth and strength for work may be called *the fuel foods*. The fuel foods are all kinds of fat, starch and sugar. Only a small quantity of the food enters into the intimate structure of the body to replace worn out body substance and to provide new material for the growth of the young child or animal. Meat, fish, eggs, cheese or milk are the essential body building foods.

The amount and kind of food required varies according to age and occupation. The growing child needs a larger proportion of building material than the grown man. A man engaged in hard manual work requires more fuel than the sedentary clerk. A woman whose time is spent on heavy housework, or on athletic games, wants plenty of fuel foods. The expectant or nursing mother has especial need for body building material. The healthy child with its ceaseless activity and steady growth demands a generous supply of both fuel and building materials.

Exposure to cold involves loss of body heat and more fuel must be burned to replace the loss. An elderly invalid needs little food, bedclothes and hot bottles prevent loss of heat and not much energy is spent on movement.

Physiologists by means of the apparatus called a calorimeter have measured exactly the output of energy and loss of heat by a man, woman or child at rest and under different conditions of work and temperature, and can calculate exactly the amount of fuel food required. This information is of

the utmost value for estimating the quantity of food which must be provided for the feeding of large numbers of people, as for an army or navy, or rationing a nation. In ordinary life the appetite is a fairly reliable guide to the quantity of fuel food required, and the more manual work or the colder the weather, the larger is the appetite.

The appetite is no guide to the right kind of food to eat, and as man has no natural instinct to help him, food cannot be correctly chosen without special knowledge. Reliable information of the value of various foodstuffs is now available and the selection of food should no longer be left to convenience and the random guidance of individual tastes. In this over-civilised country it is so much easier to eat the wrong kind of food. A certain amount of pertinacity and effort are necessary to secure really nourishing foods.

A complete diet contains eight kinds of substances which are essential for life :—

(1) *Carbohydrate*. This word stands for every kind of starch and sugar. The use of one inclusive term saves the continual repetition of a whole string of names of the foods of this class. They are :—

The flour of wheat, rye, maize (cornflour), oatmeal, barley meal, pearl barley, rice, sago, tapioca, arrowroot, custard powders, patent breakfast cereals, sugar, treacle, syrup, honey, jam.

Potatoes and bananas consist largely of starch. Fruits and many vegetables contain sugar.

(2) *Fat*. This term includes all edible oils and fats, such as meat fat, dripping, lard, bacon fat, butter, margarine, olive oil, cotton seed oil, cod liver oil, nut butters.

(3) *Protein*. This is a comprehensive term to include the lean of all kinds of meat : beef, mutton, veal, pork, chicken, game, fish. It forms an important part of cheese, milk and eggs. The use of the term *protein* again saves the frequent repetition of a number of names. Protein is the chief body building material.

(4) *Salts*. By this term is generally understood table salt, or the daily dose of some aperient salts. Chemically speaking both these are salts, but the term has a wider meaning and includes the mineral material in the foods. Salts are the ash which remains on burning food or coal, they are the

unburnable part of the fuel. The ash of the coal fire is just so much waste material, but the ash of our food contains mineral salts which are essential for life. They dissolve in the fluids of our body and play a vital part in regulating the work of different organs. If certain of these salts are absent from the food, the heart will cease to beat. The red colour of the blood cannot be formed without iron salts, nor the secretion of the thyroid gland without salts containing iodine. Lime salts and phosphates are required for the hardening of bones and teeth.

All these mineral salts will be provided if the diet is well mixed, that is, contains a variety of foodstuffs. The heating, tinning, bottling or ageing of foodstuffs does not harm the salts, but they are removed from our food in the milling of grain to make white flour and white rice. A diet consisting largely of these white cereal foods will not provide all the necessary mineral salts.

(5) *Water.* Most of our foodstuffs contain water. In this country there is seldom any shortage of drinking water. The amount taken is according to individual taste. From four to six pints of water, including other fluids, should be taken daily to flush the body and wash away waste material which otherwise will accumulate and poison the system. Sufferers from rheumatism go to "watering" places where the chief part of the treatment consists in drinking very large quantities of water. The cure may be attributed as much to the cleansing action of water upon the tissues, as to any special value of the dissolved salts. Another advantage of copious water drinking is that it lowers the blood pressure which in many middle-aged and elderly people is too high.

(6, 7 and 8) *Vitamins.* This term is now frequently used in advertisements of patent food preparations and is therefore not unfamiliar. As the name implies vitamins are chemical substances of vital importance. Three vitamins have been clearly distinguished and there appear to be others. For simplicity the vitamins are called A, B and C. If any one of the three is absent from the food for three or four months, death is the result. One vitamin cannot be substituted for another in the same way as one carbohydrate can be replaced by another, or one fat by another. Oatmeal can be used instead of rice, olive oil instead of lard and in the case of

FOOD AND HEALTH

proteins, cheese can replace meat, but each vitamin must be placed in a class by itself and must be considered individually.

Each vitamin is present in very small quantities in different foods and thus they are difficult for the chemist to extract. The comparative vitamin value of the various foods can only be ascertained by means of feeding experiments on animals, or in the case of human beings by practical experience.

The expression "vegetable salts" is often wrongly used and really refers to vitamins and not to salts. From the chemical point of view salts are all of the same character, whether they are vegetable salts or mineral salts. Vitamins are not mineral salts because they are destroyed by processes which leave the mineral salts unharmed. Vitamins are not vegetable salts because the concentrated preparations of the vitamins, which have been prepared, do not possess any of the characters of a true vegetable salt. The vitamins and the salts are generally present in the same part of the animal or plant and may be removed together as in the milling of grain, hence the confusion.

The heating, ageing and drying of foods has a harmful effect upon some of the vitamins and they are destroyed by certain chemicals (see p. 60) These processes do not affect the vegetable salts which can be preserved in tinned or bottled foods for years.

One of the most important facts about vitamins is that they cannot be made in the human body and must therefore be supplied in the food. They are produced in plants and vitamins found in animals have come from the plant food. Vegetarians have one advantage over meat-eaters, that they get their vitamins direct from the plants.

Very few foodstuffs contain all the vitamins, but some are particularly rich in vitamin-A, while others supply -B, or -C.

Vitamin-A is generally found in all the animal fats, except lard.

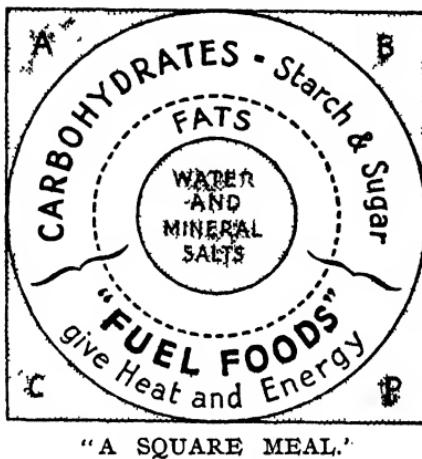
Vitamin-B is found chiefly in the seeds of plants, and in the eggs and internal organs of animals.

Vitamin-C is in fresh fruits and vegetables.

Under modern conditions of life the vitamins may be unintentionally omitted from the diet, or consumed in insufficient amounts. It is our purpose to show how this may happen and how it may be avoided.

For practical purposes the easiest way in which to think about a complete diet is in the form of a diagram which we have called "A Square Meal" and is illustrated in fig. I and in the middle of the frontispiece.

FIG. I.



"A SQUARE MEAL."

The large white ring represents the bulk of the food, the fuel foods, which consist of carbohydrate (starches and sugars) with a moderate quantity of fat. To a considerable extent the proportion of fat to carbohydrate can be varied without ill-effect, but too high a proportion of fat may upset the digestion.

The salts and water are also included in the central part¹ of the diagram.

To represent a square meal, four corners must be added and these in the diagram are marked A, B, C, and D, as they are filled by the three vitamins and protein. For easy remembrance we may think of the A corner as coloured yellow, because the yellow fats are the good ones. The B corner is coloured brown to represent the wholemeal cereals which are brown. The C corner is coloured green like the growing plant which gives us fresh fruits and vegetables;

¹This representation is purely diagrammatic, and is not intended to show exact proportions

the corner P is red, because meat is red (see frontispiece).

In the frontispiece the diagram of the square meal is set within a large square subdivided into four sections so it can be seen at a glance which articles of food must be provided to fill each corner. If the corners are suitably filled and the appetite satisfied with these good foods, the meals will be square ones and the diet well balanced.

Many foodstuffs in common use do not contain vitamins. Lists of these poor foods are shown at the sides of the square and placed for comparison opposite foods of a similar nature but containing one or more vitamins. A large consumption of the foods poor in vitamins should be avoided.

CHAPTER III

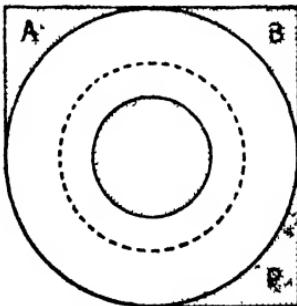
VITAMIN-C AND SCURVY: THE NEED FOR FRESH FRUITS AND VEGETABLES

THE need for fresh fruits and vegetables was realised centuries before scientists discovered vitamins. If fresh fruits and vegetables are omitted from the diet, the dreadful disease scurvy follows. The special substance in these fresh fruits is now known as vitamin-C, this name having been given so as to bring the substance into line with vitamins -B and -A. It is easy to remember the connection C and SCURVY, B and Beri-Beri. In scurvy the C corner of our Square Meal is missing as in fig. 2.

In former days scurvy was prevalent in this country during cold winters. Sailors on long voyages suffered severely from it. Consequently it was believed to be caused by exposure to cold and wet. There were thousands of deaths from this disease every year. The heavy mortality from scurvy nearly prevented the completion of Vasco da Gama's voyage of discovery in 1498 round the Cape of Good Hope; he lost 100 out of 160 men from scurvy. In some of our wars in the past more men died from scurvy than from wounds, and even during the last war there were cases of the disease amongst our troops and particularly amongst the Indian troops in Mesopotamia.

Scurvy, though rare now-a-days in Western Europe, is still common in Northern Russia. Scurvy is not uncommon amongst bottle-fed infants.

FIG. 2.



A diet without vitamin-C leads to SCURVY.

Popularly and wrongly believed to be a skin disease, scurvy is really a disease of the whole system, as will be made clear by an account of the chief symptoms. The complexion becomes pale and sallow. There are acute pains in the joints. Swellings in the limbs are caused by bleeding under the flesh. A general weakness of the walls of the blood vessels is also shown by nose bleeding, the appearance of purple spots and marks like bruises on the skin, bleeding of the gums and other symptoms. The breath is most offensive and the teeth are buried by spongy swellings. The teeth get loose and fall out and the bones may fracture spontaneously. Unless the progress of the disease is checked, it ends fatally.

A timely change of diet works the most remarkable cure even in apparently hopeless cases, as illustrated by the following account taken from Lind's treatise on scurvy (1757).

"A sailor in the Greenland ships was so over-run and disabled with scurvy, that his companions put him into a boat and sent him on shore, leaving him there to perish without the least expectation of recovery. The poor wretch had quite lost the use of his limbs; he could only crawl about the ground. This he found covered with a plant which he, continually grazing like a beast of the field, plucked up with his teeth. In a short time he was by this means perfectly recovered, and upon his returning home it was found to be the herb 'scurvy grass.' "

Equally dramatic are the cures effected by orange juice in infants suffering severely from scurvy.

In the eighteenth century several valuable treatises were written dealing with this disease. The medical name for scurvy is *scorbutus* and the fruits and vegetables which cure the disease are called *antiscorbutics*. The most famous English work on scurvy was by Lind. He tried to impress his own generation by making the first exact experiments upon the curative value of different reputed antiscorbutics. He tested all the best known remedies upon men who were suffering from scurvy and found that by far the most active was orange or lemon juice. Either of these caused rapid improvement. Lind in his day found that traditional beliefs were as difficult to combat as we find them now, for he wrote:

"Some persons cannot be brought to believe that a disease so fatal and dreadful can be prevented or cured by such easy

means. They would have more faith in some elaborate composition, dignified by the title of an antiscorbutic golden elixir, or the like.

"Facts are sufficient to convince the unprejudiced.

"It is no easy matter to root out old prejudices or to overturn opinions which have acquired an establishment by time, custom and great authorities."

Captain Cook made use of the information gained by Lind and was successful in maintaining good health and freedom from scurvy on his long voyages of discovery.

Lind knew one other very important fact about the prevention of scurvy and that was the uselessness of dried vegetables as a substitute for fresh ones. Since his day, however, there have been some flagrant examples of ignorance of this fact. In the American Civil War dried vegetables were plentifully provided and did not prevent scurvy. Dried vegetables have been repeatedly tried in the British Navy and found useless, yet in spite of all this evidence the British public during the recent War were asked to send dried vegetables to our fleets and prisoners of war.

One other fact in the history of scurvy must be remembered. Scurvy was eliminated from our Navy by the issue in 1795 of 1 oz. of lemon juice per man per day. A ration of $\frac{1}{2}$ oz. per day had previously failed to prevent scurvy. The fruit used at this time was the ordinary lemon, but the juice was called "lime" juice, hence the reputed value of lime juice as an antiscorbutic. Towards the middle of the nineteenth century, instead of the Mediterranean lemon the Navy used the juice of the West Indian lime, that is the real lime, and it proved a failure as an antiscorbutic. Lime juice has been tried in various arctic expeditions and has never been a success.

The value of fresh fruits and vegetables as part of the diet was pointed out again and again by distinguished medical men during the nineteenth century, but even now it is not sufficiently realised that tinned, bottled or dried fruits and vegetables cannot take the place of fresh ones.

Captain Cook noticed symptoms of scurvy in goats and sheep after they had been several months on board ship. Pigs also suffer from scurvy, but it is remarkable that certain animals, such as rats, cats, and birds do not get this disease even when

their food contains no antiscorbutic. Some recent work has shown that the livers of rats and birds contain vitamin-C although their food has not contained this vitamin. These animals must therefore have the special faculty of making vitamin-C from some other substance in the food, possibly from vitamin-B.

Our recent knowledge of the cause and prevention of scurvy dates from 1907-1912, during which period two Norwegian experimenters, Holst and Frölich, were studying the cause of outbreaks of so-called "ship beri-beri" in Norwegian sailing ships. This disease turned out to be a combination of scurvy and beri-beri. The value of their observations was at first overlooked and it was only during the stress of the War, when scurvy broke out amongst our troops, that their work was appreciated.

Further investigations on the same lines were carried out by Dr. Harriette Chick and her colleagues at the Lister Institute in order to find out the most efficient antiscorbutic for Army use.

Holst and Frölich had discovered that the guinea-pig if kept upon a diet of oats, or bread, and bran and water, died in about twenty-one days showing symptoms like those of scurvy in man. If fresh vegetables were included in the diet, the guinea-pigs grew and lived quite normally and showed no signs of the disease.

The guinea-pig proved to be a very useful animal for the purpose of testing the antiscorbutic value of different fruits and vegetables and making a standard of comparison. The antiscorbutic value of a number of fruits and vegetables, together with the effect upon them of cooking, drying, ageing and of various chemicals has now been examined, using the guinea-pig, or occasionally the monkey, as the test animal. We now know the least or *minimal* daily quantity of many fruits and vegetables which is required to prevent scurvy. These values, together with the calculated figures for man's requirements, are put together in the following table:—

DAILY AMOUNTS TO PREVENT SCURVY.

		Guinea-Pig.	Man.
Cabbage, raw	-	10 oz.	$\frac{1}{2}$ oz.
" cooked 20 minutes	-	10 "	2 "
" cooked 1 hour	-	10 "	10 "
Lemon or Orange Juice	-	10 "	1 "
Tomato, raw	-	10 oz.	1 oz.
" tinned	-	10 "	5 "
Swede Turnip, raw juice	-	10 "	1 $\frac{1}{2}$ "
Runner Beans, raw	-	10 "	3 "
Lime, fresh juice	-	10 "	3 "
Potato, raw	less than	10 "	7 "
" cooked 15 minutes	-	10 "	7 "
" cooked 1 hour	-	10 "	10 "
Apple, raw	-	10 "	7 "
Banana	-	10 "	7 "
Carrot, raw	-	10 "	13 "
Grapes	more than	10 "	30 "
Turnip, White, raw	-	10 "	30 "
Milk, raw	-	3 $\frac{1}{2}$ "	70 "
			i.e., 3 $\frac{1}{2}$ pints.

The figures for man have been calculated from the guinea-pig figures by using the old observation in the Navy that 1 oz. of lemon juice daily prevented scurvy in the men, while $\frac{1}{2}$ oz. was insufficient. Man's requirements are therefore twenty times as great as those of the guinea-pig. According to Hess the infant requires ten times as much as the guinea-pig, that is, half as much as the adult.

Only after a consideration of this table can it be realised how much of each fresh fruit or vegetable must be eaten to fill up the C corner of the "Square Meal." Several of the fruits stand out pre-eminently—the orange, lemon and raw tomato. Other raw fruits such as the apple and banana are no better than cooked potato. If no other antiscorbutic food is eaten, the figures show that at least two apples or two bananas must be taken daily. The most disappointing of the fruits is the grape. The fresh lime has some antiscorbutic value but is not nearly as good as the lemon and hence its failure to prevent scurvy in the Navy and in arctic expeditions. Raw cabbage is very good and in the same class must be included lettuce, watercress, and other green salads.

It is very curious that there is so much difference amongst the root vegetables; swede is good and turnip and beetroot poor; carrot is intermediate.

The table also gives the results of the experiments which were made to test the effect of cooking upon the vegetables. In every instance the cooking has a harmful effect upon this vitamin, the longer the cooking the greater the damage. Boiling for a short period is less harmful than slow cooking at a lower temperature. Cooking after the hay-box fashion and stewing are the worst ways of treating vegetables. Twice cooking destroys all the vitamin-C, hence mashed and fried potatoes, made from left over boiled ones, are valueless as a source of this vitamin.

With this knowledge about the effect of heat it is clear that jam and tinned and bottled fruits and vegetables will have lost their value. Tinned tomatoes may be excepted from this general condemnation, as acid fruits like the tomato, orange and lemon do not suffer so badly when heated. It is, however, safer to assume that tinned fruits and vegetables are useless as antiscorbutics as we do not know exactly what the manufacturer may have done to them and each brand may vary. The only guide to the antiscorbutic value of these preparations is a test upon animals.

The ageing of fruit and vegetables has been definitely shown to reduce their antiscorbutic value; thus new potatoes and carrots and freshly picked apples will contain more vitamin-C than those which have been stored for some months.

A common household practice is the addition of soda to vegetables during cooking to retain their green colour. Soda and other alkalies are fatal to this vitamin. There is no need to add soda as vegetables cooked for a short period, not more than twenty minutes, keep their green colour, have more flavour and also retain much more of this vitamin.

Fresh meat contains little vitamin-C. It is effective only when huge amounts are eaten, such as the Eskimo is capable of doing, 15 lbs. of meat in less than fourteen hours. The liver contains a considerable amount of vitamin-C and eaten raw is one of the chief antiscorbutic foods of the Eskimo.

The antiscorbutic value of milk on account of its use as a food for infants has been carefully studied by all workers on scurvy. Unheated milk as the sole food is generally found to contain enough vitamin-C for the infant. This depends to a large extent upon whether it is summer or winter milk. It has been proved both here and in America that the milk

of cows at grass in summer has much more vitamin-C than the milk of cows fed on oil cake and hay in the winter (see also under vitamin-A, p. 33).

The antiscorbutic value of milk also depends very largely upon the handling and heating which it has undergone. Like vegetables, milk suffers every time it is heated. Many cases of infantile scurvy have been traced to pasteurisation at the dairy followed by boiling the milk in the home.

The treatment of milk with sodium citrate or sodium bicarbonate, as is so often done to make it more digestible, destroys the vitamin-C and is another cause of infantile scurvy. The value of milk as an antiscorbutic is shown by the figure of the table. Protection by it is not effective unless the adult gets 3½ pints of raw milk daily. The potency of milk as an antiscorbutic is much exaggerated.

Bottle-fed infants are the only section of the community who are in danger of getting definite scurvy. The care taken to protect their milk from harmful germs and to make it easily digestible by adding sodium citrate, leads to the destruction of the antiscorbutic vitamin. Scurvy in children is called Barlow's disease, or sometimes by the inaccurate name scurvy-rickets: inaccurate because scurvy is quite distinct from rickets. Cases of acute infantile scurvy are rare, but many slighter cases pass unrecognised and recover gradually as the diet becomes more varied. The symptoms in mild cases may be nothing more definite than pallor, loss of appetite, fretfulness and failure to gain in weight. Purple marks on the gums during teething indicate a rather more advanced state of scurvy. Swellings in the legs and knees are often mistaken for rheumatism. The child with scurvy cries on being handled but in rickets there is no tenderness.

A daily dose of orange juice speedily restores health. As a preventive it is advisable to give every bottle-fed child a small amount of orange juice daily, beginning with one teaspoonful and gradually increasing the amount. Grape juice is a very poor antiscorbutic and in the quantities in which it is given to infants is quite useless.

Ordinary dry seeds have no antiscorbutic value, but seeds become a very valuable source of vitamin-C when they are germinated. This is quite easy to do. Dried peas are the most suitable seed. It is best to use those sold by the

pound. The ones in packets do not germinate so well as they are usually tinted and have been in contact with the little bag of alkaline salt which is sold with them. The whole, unsplit, peas are soaked for twenty-four hours in water, transferred to a damp cloth and kept warm, moist and exposed to air till they begin to sprout. The warmer the room the sooner they begin to grow and they are ready in about three to four days. These sprouted peas need much less cooking and have much more flavour. They have often proved a splendid remedy for scurvy and are most useful for armies abroad or in winter when green vegetables are scarce.

There is enough vitamin-C in our ordinary mixed diet to prevent actual scurvy but it must be considered whether all the little amounts added together make up the full requirement to ensure health.

CHAPTER IV

VITAMIN-B AND BERI-BERI: THE NEED FOR WHOLE CEREALS

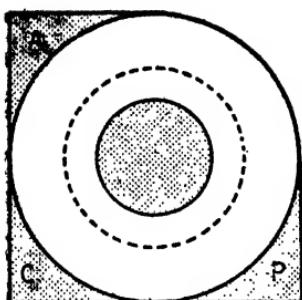
SOME of the most interesting and significant facts in nutrition have come to light in the study of the disease beri-beri. This disease occurs mainly amongst the rice-eating peoples of the East, but it has also developed in Australia, the United States, Europe and many other parts of the world. It is not confined to the tropics, nor to rice-eaters. There are many examples of the occurrence of beri-beri amongst eaters of white bread.

Dr. Little recorded outbreaks of beri-beri in Labrador and Newfoundland. There were no cases of beri-beri in these countries in the old days when wholemeal flour was in general use, but after white flour became the chief food during the winter months beri-beri appeared every spring. He described how a ship laden with wholemeal flour was stranded upon the Newfoundland coast. In order to refloat her a quantity of the flour was removed and was consumed by the inhabitants of the district, and for more than a year after no more cases of beri-beri were reported.

The story told by Holst of an old sea-captain affords another instance of beri-beri on a diet of white wheaten flour. In 1894 it was made compulsory to supply Norwegian sailors with white flour with the idea of making their life at sea more pleasant. Rye flour had previously been used. The captain objected to the new regulations and for his own use took rye flour. The crew, fed on white flour, fell ill with beri-beri and were cured by biscuits made from the captain's private supply of rye flour.

Beri-beri has also been observed amongst the eaters of manioc, or tapioca, in Brazil. Hence all kinds of white cereal foods are concerned in the causation of beri-beri.

FIG. 3.



A diet without vitamin-B
leads to BERI-BERI.

beri-beri during the later days of the siege of Kut was traced to the consumption of the Indian wholemeal flour by the British troops after all their own white flour had been used up.

The disease beri-beri is characterised by severe nervous and heart symptoms and by digestive troubles. The latter, though mentioned last, really appear first and are the most important, as they seem to form the basis of the ultimate nervous troubles. Poisons absorbed from the diseased digestive tract may be the cause of the final paralysis of the limbs. In some cases there is also much oedema, that is, the limbs are swollen and distended with fluid as in dropsy. Like scurvy, the disease is fatal unless arrested by a timely change in the food.

The establishment of large machine mills for preparing white rice led to an enormous increase of beri-beri, but only gradually was the connection between beri-beri and the food supply realised.

The sailors of the Japanese Navy suffered greatly from beri-beri and a special investigation of its origin was made by Takaki, Medical Inspector General of the Japanese Navy. He concluded that the freedom from beri-beri amongst the European navies was connected with a higher protein diet and persuaded the Japanese naval authorities to make a change in the men's food.

Before this change 32 per cent. of the men suffered from beri-beri but after the introduction of the new rationing in

The diet which produces beri-beri has the B corner of the "Square Meal" missing, as shewn in fig. 3.

Closer attention was given to the cause and prevention of beri-beri after the outbreaks of this disease among our troops in the Dardanelles and Mesopotamia during the War. The British troops on their white bread suffered severely, but the Indian troops on "atta" and "dahl," that is, wholemeal flour and the chick-pea, did not have the disease. The freedom from

1884, the disease was practically stamped out. Three years after the change there was not a single case, although the personnel of the Navy had meanwhile been doubled. The most remarkable effect of this diet is shown by the report of sickness from beri-beri during the Russo-Japanese War. There were 200,000 cases in the Army, but none in the Navy. It is instructive to consider the difference in the food of the two Services, as shown by the rations they received during the siege of Port Arthur:—

<i>Japanese Navy.</i>	<i>Japanese Army.</i>
1 lb. of Meat.	5 ozs. of Meat.
20 ozs. of Rice.	30 ozs. of Rice.
10 ozs. of Whole Barley.	

At first sight it would appear that Takaki was right in attributing the cause of the disease to lack of meat. Experience from other countries, however, did not confirm the theory that meat was the preventive agent of beri-beri. It is now known that it was the whole barley which was the preventive in this case.

The first real insight into the cause of the disease was given by the observations of Eijkman in 1897. Eijkman noticed that some fowls kept at a prison in Java, at which he was chief medical officer, fell ill and suffered from a peculiar form of paralysis which he called polyneuritis. No micro-organism could be found that might be the cause of the disease. Eijkman discovered that the birds were fed upon rice left over from the prison food and he made experiments upon the feeding of birds with various kinds of rice. Some of the birds were fed on the whole grain, some on half-peeled rice and some on white rice. Only those fed on white rice suffered from the disease. These birds were cured by being given the whole grain, or by the half-peeled rice. The disease was produced by feeding with any sort of white rice: fresh, old, raw or cooked, and it could be cured by adding the rice bran to the white rice.

Not only white rice, but also sago or tapioca as the sole food, caused the disease amongst birds.

Eijkman, with the help of a colleague, Vorderman, put the result of the bird experiments to a practical test in the gaols of Java, containing altogether about a quarter of a million

prisoners. The inmates of some prisons were given white rice and in others they were given half-peeled rice.

In the prisons receiving white rice 1 in 39 of the inmates developed beri-beri.

In the prisons receiving half-peeled rice, only 1 in 10,000 of the inmates developed beri-beri.

Another very valuable piece of work upon this subject was done by Fraser and Stanton in the Malay States. They confirmed Eijkman's results and made a further advance by showing that the preventive substance in the whole rice grain, or the rice bran, could be extracted with alcohol. They thus proved that the cause of the disease was the *absence* from the food of some chemical substance essential for life.

Many unsuccessful attempts were next made to isolate the actual preventive substance from the bran of rice and from other foods. Very concentrated extracts have now been prepared and it appears probable that the active substance will be isolated and analysed.

Eijkman and his colleagues tested various foods for their protective action against beri-beri and were able to divide foods into two main classes, those containing the protective substance and those not containing it. They were:—

FOODS CONTAINING ANTI-BERI-BERI SUBSTANCE.	FOODS NOT CONTAINING ANTI-BERI-BERI SUBSTANCE.
Rice Bran.	White Rice.
Half-peeled Rice.	Tapioca.
Potato.	Sago.
Barley, whole grain.	Peeled Barley (= Pearl).
Beans, dried.	Sterilised Foods.
Rye Flour.	White Flour.
Milk.	
Yeast.	

Amongst those foods not containing the preventive substance may be noticed sterilised foods, or in other words, canned foods made at high temperatures and under pressure. This was contrary to the belief then current that beri-beri was due to an infection.

The anti-beri-beri substance seems to be the same as vitamin-B.

The discovery of vitamin-B came from quite independent work upon the feeding of animals. It was believed that

animals could exist upon the three main food materials, protein, carbohydrate, and fat, together with salts and water. Sir F. Gowland Hopkins showed that this was impossible and that besides these known food constituents something else was necessary. The unknown he called an *accessory food factor*. He found that a small quantity of milk added to the pure foods every day supplied all that was necessary for the growth of rats.

At the same time very extensive researches were being carried out in America by Osborne and Mendel and they also found that the purified protein, fat and carbohydrate of an artificial diet, together with suitable food salts, were not adequate for the growth and life of animals. The addition of milk was necessary. Their further experiments, as well as those of McCollum and Davis, showed that the milk contained *two* unknown accessory food factors. One was found in the cream and called the *fat-soluble* and the other in the water and called the *water-soluble* factor. For convenience they were called A and B respectively. Each of these unknowns is essential for life. The name *vitamin* was coined for the substance in rice bran, and as it was found that the foods which can replace the watery part of milk were the same as those which can prevent beri-beri, they were believed to be identical. So the anti-beri-beri substance is now called *vitamin-B*.

The examination of foodstuffs for the presence of the anti-beri-beri substance or *vitamin-B* has been carried out mainly in this country at the Lister Institute by Cooper and later by Chick and Hume, and is being studied now by Plimmer and Rosedale.

The following table gives the *vitamin-B* containing foods and at the same time shows those which do not contain the *vitamin-B*.

FOODS CONTAINING VITAMIN-B.

- Wholemeal Flour.
- Whole Barley.
- Whole or Half-peeled Rice.
- Oatmeal.
- Rye.
- Nuts.
- Eggs. Liver.
- Milk.
- Peas. Beans. Lentils.

FOODS NOT CONTAINING VITAMIN-B.

- White Flour.
- Pearl Barley.
- White Rice.
- Sago.
- Tapioca.
- Canned Meats, Fish.

Reference to the previous table (p. 24) shows that the good foods are the same in both tables, and consequently it is believed that the anti-beri-beri substance and vitamin-B are identical.

For practical purposes in nutrition it is not enough to know that certain foods contain vitamin-B. We want to know how much there is in each of the foods and how much should be eaten. A certain number of experiments have been made on the comparative vitamin-B value of different foods. Most of these data have been obtained by finding the amount which is required to cure a pigeon in a state of paralysis. A smaller number have been made to find out how much should be added to a diet of white rice to prevent beri-beri. The preventive values are the most reliable guide. There are at present no data for man's requirements, but the quantities for rats and pigeons have been collected together in the following table :—

QUANTITIES OF FOODS PREVENTING BERI-BERI.
FOR ADULT PIGEONS.

				per day	per cent.
Lentils	-	-	-	3.0 gm.	18
Barley, whole	-	-	-	3.7	22
Egg, yolk	-	-	-	3.0	18
Liver, Ox	-	-	-	3.0	18
Heart, Ox	-	-	-	5.0	30
Brain, Ox	-	-	-	6.0	36
Muscle, Ox = Beef	-	-	-	20.0	50
Milk	-	-	more than	35.0	—
Wheat Germ	-	-	-	1.5	4.5
Yeast Extract	-	-	-	1.0	3.0

FOR RATS.

Carrot	-	-	-	—	15
Swede	-	-	-	—	15
Dried Cabbage	-	-	-	—	15
Dried Spinach	-	-	-	—	10

FOR PIGEONS.¹

Wholemeal Flour	-	-	-	—	75
Maize	-	-	-	—	75
Rye	-	-	-	—	55
Whole Barley	-	-	-	—	65
Millet, Dari	-	-	-	—	60
Oatmeal	-	-	-	—	95
Bran	-	-	-	—	30
Middlings	-	-	-	—	30
Wheat Germ	-	-	-	—	10
Yeast Extract	-	-	-	—	10
Potato	-	-	-	—	90

These figures require explanation. They show what percentage of the various foodstuffs must be added to white rice (or other white cereal) to prevent the onset of beri-beri. The best foods are those with the lowest percentage number.

Another way of looking at the figures is to say that 75 per cent. of wholemeal flour supplies enough vitamin-B to compensate for the addition of 25 per cent. of white rice or any white cereal, or sugar, or other food not containing vitamin-B. In the case of oatmeal only five per cent. of such a food can be added.

¹ These figures may need slight alterations as the experiments are still in progress by Plimmer and Rosedale. Other experiments indicate that the rat needs less vitamin-B than the pigeon.

In most cases very large amounts of vitamin-B containing foods are required. In the case of protein, that is, meat foods, the quantities vary from 20 to 50 per cent., impossible amounts of meat except for Eskimos.

There are only two foodstuffs which can be considered very rich in vitamin-B. They are wheat germ and yeast extract. Ten per cent. of either of these is all that is required to compensate for 90 per cent. of white flour, white rice or sugar. Wheat germ is not a commercial article, but its high value shows the great importance of leaving it in our bread and flour. The amount of wheat germ which is removed from white flour is also shown by the good value of bran and middlings.

Yeast extract is thus the only food sufficiently rich in vitamin-B with which to supplement a diet consisting largely of white flour, sugar, and other things lacking vitamin-B.

It has been claimed that the addition of yeast to flour in the making of bread is enough to make the bread equal to wholemeal. In order to balance the white flour ten per cent. of yeast must be used, but usually about two per cent. is added and thus white bread is not compensated. Moreover, such bread does not carry any surplus of vitamin-B to make up for any other white cereal or sugar in the diet.

Vegetables are usually considered to be rich in this vitamin, but the figures do not altogether confirm this belief. The figures given in the table are for *dried* cabbage and spinach and must be multiplied by 90 to allow for the water in them. The quantities are then too large to eat. Carrots and swedes are better, but must bear a proportion of 15 per cent. of the total food if they are the sole source of vitamin-B. For each 1 oz. of carrot eaten 6 ozs. of white sugar or of flour may be taken.

From the above data it may be concluded that the vitamin-B in plants is concentrated in the seeds, roots and tubers and not in the leaves like vitamins-A and -Q.

Although potatoes are poor in vitamin-B in comparison with yeast and eggs, they must be considered a most valuable source of vitamin-B, because they generally form a large proportion of the ordinary diet in this country. Every 1 oz. of potato allows for $\frac{1}{10}$ oz. of sugar.

Flour is the foodstuff most largely consumed in this country and if white flour were abolished and wholemeal flour eaten instead, then there would be no fear of a shortage of vitamin-B.

The symptoms of paralysis characteristic of beri-beri are generally the only symptoms considered and because this paralysis is very rare in this country it is concluded that there is plenty of vitamin-B in the ordinary diet. The earlier manifestations of beri-beri are overlooked. Col. McCarrison, I.M.S., in his book on *Deficiency Diseases*, lays greatest stress upon the order of appearance of the symptoms :—

First of all there is a loss of appetite, or there is a depraved appetite, that is, a craving for unnatural food—animals eat their excreta or feathers.

Indigestion.

Bouts of diarrhoea may alternate with constipation.

Colitis, that is inflammation of the colon or large bowel.

The general condition is very poor ; there is loss of weight, weakness, headache, anaemia, unhealthy skin, sub-normal temperature, heart trouble.

The observations by Plimmer and Rosedale upon birds on diets containing too little vitamin-B coincide closely with those of McCarrison and lead to the same conclusion, that the attention should be focussed upon the earlier signs of the disease and not upon the paralysis. On a diet containing a *shortage* (not *absence*) of vitamin-B, birds show the above signs of ill-health, and before the appearance of paralysis they generally die showing stagnation of the food in the gut (constipation or stasis) and appendicitis.

These are the common disorders of the present day and they are exactly what one would expect to find in a people living for the most part on white flour, tinned foods, and sugar. It is essential for every one to make certain that he gets plenty of vitamin-B in the food. It is most easily obtained by eating wholemeal flour and potatoes, as shown by the experiments with pigeons. It is possible that man's percentage requirements are less than those of the pigeon, and more like those of the rat, i.e., about one-third of the quantity for pigeons. Still, it is safer to base the quantity for man on the higher figure rather than underestimate.

CHAPTER V

VITAMIN-A AND RICKETS: THE NEED FOR ANIMAL FATS

THE most obvious of the diseases due to badly chosen diet is rickets. Bow legs are a common deformity of children who have suffered from severe rickets. In slighter cases the bulging forehead may be noticed, but the majority of cases are too slight to be detected except by careful medical or X-ray examination.

Rickets is not entirely a disease of the bones, but affects the whole body. The muscles are flabby and the ligaments are soft and lax. The disordered state of the nervous system is shown by the frequent occurrence of convulsions in rickety children. Even in the early stages of the disease the vitality is lowered and these children are easily attacked by bronchopneumonia or other infections. The number of these slight cases of rickets is not generally realised. Some years ago Lawson Dick stated that 80 per cent. of the children in the L.C.C. schools were rickety. It would appear that slight rickets in childhood is the primary cause of the large number of rejections that are now being made from men entering as army recruits. The most recent figures show that 82 per cent. in the London area were rejected as physically unfit, and these figures were considered typical for the whole country. These figures correspond with the percentage of rickets in London schools a few years ago. General Sir Wilfred Beveridge stated that the chief cause of the men's rejection was malnutrition during childhood. This does not necessarily mean that they had been underfed but that they had been fed on wrong kinds of food during their period of growth, and so on reaching manhood could only be classed as C3 individuals.

It is encouraging to read in the report by Dr. Corry Mann¹

¹ Medical Research Council, Report No. 68. *Rickets. The Relative Importance of Environment and Diet as Factors of Causation: an Investigation in London*, by H. Corry Mann, O.B.E., M.D., 1922.

that the number of cases of rickets in London is diminishing, largely as the result of the good work done by the maternity and infant welfare centres, and by school nurses working in conjunction with the school medical officers. If these conditions be continued, Dr. Corry Mann prophesies that in ten years' time there should be few cases of rickets in London.

What is the cause of rickets? There are many treatises upon the subject by distinguished medical men and it is difficult not to conclude that the principal cause is connected with food. Two main theories upon the cause of rickets have been held for the last forty years:—

The one believes it to be due to unhygienic conditions with lack of fresh air, exercise and sunlight; the other ascribes it to errors in the diet.

It is our purpose to examine the dietetic theory of the origin of rickets and to correlate it with the effect of light and exercise.

In considering the food question it has become quite clear that three agents at least are concerned in the production of the disease. These are:—

(1) Lime salts and phosphates.

(2) A fat-soluble vitamin which is either vitamin-A, or a special *anti-rachitic* vitamin found in the same foods as vitamin-A. For practical purposes foods which supply vitamin-A also supply the rickets-preventing vitamin.

(3) Excess of carbohydrate, that is, starch and sugar.

It is obvious that hard bones cannot be formed unless the hardening agents, lime salts and phosphates, are contained in the food in sufficient quantity.

The function of the vitamin apparently governs the deposition of these mineral elements in the bones. The necessary salts may be contained in the food, but cannot be used if there is too little of the vitamin.

A shortage of whole milk in the diet is at the bottom of practically all cases of rickets. Milk supplies both the mineral salts and the vitamin.

Excess of carbohydrate added to the milk leads to a smaller consumption of milk by the child and at the same time causes the diet to be short of vitamin-B as well as vitamin-A.

It has taken a long time to reach the conclusions so briefly

summarised here. It has been necessary to study experimentally each factor, and also to examine and tabulate the history of the development of rickets in children in a very large number of cases.

It is best to consider first the work upon the vitamin. It will be remembered that on page 25 it was stated that milk contained two unknown substances, one in the cream, called fat-soluble A, and one in the watery part, called water-soluble B. Water-soluble B appeared to be identical with the anti-beri-beri substance discovered by independent researches. The fat-soluble A is either identical with or closely associated with the anti-rachitic, that is, rickets-preventing vitamin in milk. Vitamin-A is connected with growth and the anti-rachitic vitamin with calcification of bones.

The discovery of fat-soluble A in cream led to an examination of other fats for its presence. It became evident that fats could be sharply divided into two groups, the "good" fats containing A, and the "bad" fats not containing it. They are given in the following lists:—

<i>Good Fats.</i>	<i>Bad Fats.</i>
Butter or Cream.	Lard.
Cod Liver Oil.	Almond Oil.
Egg Fat.	Olive Oil.
Kidney Fat (Suet).	Cotton Seed Oil.

These fats can be grouped roughly into animal fats as "good" and vegetable fats as "bad." There is one exception—lard—partly due to the feeding of the pig and partly to the refining processes to which lard is subjected.

Though oils extracted from seeds contain so little vitamin-A, the case is quite different with other parts of the plant. Green vegetables contain comparatively large quantities of vitamin-A. It is formed in the green parts of plants by the action of sunlight. The yellow leaves which are not exposed to the sun do not contain it, hence vitamin-A is found in the green outer leaves of the cabbage and lettuce but not in the heart.

Green plants are the primary source of vitamin-A in the livers of cod and other fish. In the spring time there is a great growth in the Northern seas of green algae, microscopic green plants. These form the food of minute floating animals

which in turn are eaten by small fish and these again by larger fish, such as the cod. The vitamin-A is transferred from the smaller to the larger fish during digestion and in some way becomes concentrated in the liver of the cod. It is easy to understand why cod liver oil is so valuable; it contains the vitamin collected from an enormous quantity of plants. In the period preceding spawning there is also a concentration of the vitamin in both the hard and soft roe. Fish roe is thus an especially valuable food for children.

Green grasses have been proved to be the origin of vitamin-A in milk. Experiments carried out both here and in America showed that the milk from grass-fed cows contains twice as much vitamin-A as milk from stall-fed cows. In other words, summer milk, when the cows are at pasture, is of far better quality than the winter milk (cf. vitamin-O, p. 18).

It is thus clear that the amount of vitamin-A in the milk depends upon the food of the animal. The amount of this vitamin in cow's milk is greatly increased if the cow is given cod liver oil in its food. These facts prove the importance of feeding a mother nursing her infant on food containing vitamin-A. She must have food from the good list of fats or her milk will be as poor as that from a stall-fed cow.

The amount of cream in milk is no guide to its vitamin-A value. Winter milk, poor in the vitamin, may be more creamy than summer milk.

The dependence of the vitamin value of milk upon the food of the animal explains why pig fat contains practically no vitamin-A. Pigs are usually not fed upon green stuff. Pigs fed upon green stuff give a fat which contains vitamin-A.

A comparison of the vitamin-A value of fats has not been made in such detail as for the foods containing vitamins C and B. There are only at present a few available figures:—

Foodstuff.	Quantity per Day for Rats.	Percentage of Total Food.
Cod Liver Oil	- 0.02 to 0.002 gm.	0.2 to 0.02 per cent.
Cod Roe	- 0.2 gm.	2
Butter	- 0.2 to 0.4 gm.	2 to 4
Whole Milk, fresh, con- densed or dried	- 2 c.c.	20
Cabbage (green part)	1.5 gm.	15
Tomato, dried	- 0.1 gm.	1
" fresh would be 0.1 X 90		90

These figures show how rich cod liver oil is in comparison with butter and other good fats. Cod liver oil is estimated to contain about 250 times as much vitamin-A as butter, but samples of cod liver oil vary considerably.

The effect of heat and of exposure to air upon this vitamin is of great practical importance. In the absence of air vitamin-A is not destroyed by heat. Sterilised milk and canned meats should therefore contain it, as they are prepared in closed vessels. Dried and condensed milks are generally prepared in the absence of air and should contain vitamin-A. There is every evidence from the extensive use of dried milks that they are rich in this vitamin. Innumerable children have been brought up on dried milk, or unsweetened condensed milk, without getting rickets. Dried eggs and preserved eggs prepared in the absence of air are also good. In the ordinary processes of cooking, animal fats are exposed to air as well as heat and will therefore lose some of their vitamin-A.

Oils are often hardened by commercial processes to make solid fats, such as are used in the manufacture of margarine. Margarine made from hardened oils contains no vitamin-A. This does not imply that all kinds of margarine do not contain vitamin-A. Some varieties contain animal fat. It is safer, however, not to rely on margarine as the chief source of vitamin-A.

The part played by a fat-soluble vitamin in the prevention of rickets has been ascertained by numerous experiments on several kinds of animals, chiefly on rats and dogs. The results though varying somewhat with the different animals yet confirm each other. The earliest experiments were made by Professor E. Mellanby on dogs. A series of puppies were given the same food :—

White Bread,
Skimmed Milk, or sometimes Lean Meat,
Vitamin-B as Yeast,
Vitamin-C as Orange Juice,

so that their basal diet was correct except for fat-soluble vitamin. This basal diet was given to all the dogs but they were divided into different groups to test the effect of adding different fats and oils.

Some of the fats added had no preventive action, while

others prevented rickets. They can be arranged in two columns:—

<i>Preventing Rickets.</i>	<i>NOT Preventing Rickets.</i>
Cod Liver Oil.	Linseed Oil.
Beef Suet.	Olive Oil.
Butter.	Cotton Seed Oil.
Egg Yolk.	

Lard was intermediate between the two groups.

The fats preventing rickets correspond with the good fats for vitamin-A (p. 32), hence it is probable that vitamin-A is closely related or identical with the anti-rachitic substance in foods. The most recent work indicates that the two substances may not be identical though they are usually present together in fats.

At the same time Mrs. Mellanby studied the effect of the different fats upon the formation of the dogs' teeth. In all cases the food was soft so that the results obtained were entirely due to the chemical nature of the food and not to any variation in its hardness or softness. Puppies receiving cod liver oil had perfect teeth regularly spaced. Butter produced less perfect teeth and with linseed oil they were very imperfect.

These results pointed clearly to the effect of the vitamin in cod liver oil as controlling the calcification of the bones and teeth.

The experiments were repeated later with similar results, but it was then observed that an excess of cereal foods had a bad effect.

Experiments on rats have in the main confirmed Mellanby's results on dogs. The work on rats was on a much more extensive scale and was also concerned with the proportion of lime salts to phosphates as well as of fat-soluble vitamin in the food. If the proportion of lime to phosphate was not right, the vitamin ensured the deposition of these mineral salts in the bone. The evidence makes it clear that the vitamin has some controlling action upon the calcification of bone.

The latest experiments have been concerned with the effect of light in preventing rickets. Light appears to act in the same way as the fat-soluble vitamin in the preventing and healing of rickets, that is, it compensates for any error in

the other factors concerned. It makes up for a deficiency of anti-rachitic vitamin if that is the fault, or it helps to adjust the balance of lime salts to phosphates. It might have been expected that the beneficial action of light upon rickets was due to the actual formation of this vitamin in the skin, as it is formed in leaves under the influence of sunlight, but there is no evidence in support of this supposition. The most probable explanation is that the ultra-violet rays in sunlight and in artificial sunlight increase the circulation and bring into use any of this vitamin stored in the body, especially in the fat under the skin. This theory is supported by the fact that after a time light loses its effect, that is, when the reserve of vitamin in the body has been used up. Light can therefore tide over a temporary period of deficiency of anti-rachitic vitamin in the diet, but it cannot permanently take the place of the vitamin.

The smaller number of cases developing in the summer months may be attributed partly to the influence of sunlight and partly to the better quality of summer milk and butter. Rickets is practically unknown in warm and tropical climates where there is not this difference between the seasons in light and in food.

Together with the effect of light, there is the exposure of the body without clothes and this again stimulates the circulation. Massage has also proved of benefit for the same reason.

Mention should be made of the recently discovered power of sunlight, or of artificial sunlight, to produce anti-rachitic vitamin in oils and other foods exposed to it. These new facts may prove of great practical importance.

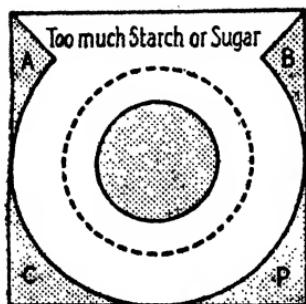
Proof of the value of the scientific work upon animals is given by the results of clinical observations upon children in hospitals where their diet could be accurately measured and controlled. In Vienna investigations were carried out over a period of three years from 1919 to 1922 by Dr. Harriette Chick and other representatives of the Medical Research Council and of the Lister Institute, who worked in co-operation with Professor Pirquet and his staff. As a consequence of war conditions practically every child in Central Europe was at that time more or less rickety. Professor Pirquet believed that rickets was an infectious disease like tuberculosis, attacking the badly nourished, but after three years' work

with Dr. Chick and her colleagues, he was convinced that rickets was entirely of dietetic origin. In large numbers of young infants maintained under exactly similar conditions of general hygiene, rickets developed only in those who received a diet poor in fat-soluble vitamin. The disease could invariably be prevented or cured by the addition of cod liver oil to an unsatisfactory diet. All the observations proved that diet is the most important factor in the prevention and causation of rickets. Exposure to sunlight or artificial sunlight compensated to some extent for a defective diet. These are exactly the same results as were obtained with animal experiments; they all point to the one conclusion that wrong diet is the primary cause of rickets.

The same conclusions are found in Dr. Corry Mann's report. He made a careful analysis of the dietetic errors in hundreds of cases of rickets in Bermondsey and Southwark and contrasted the rickets-producing diets with those received by healthy children living in the same districts under similar hygienic conditions. The healthy babies were decidedly better fed, getting more milk and animal fat and less carbohydrate. The majority of rickety children had been fed on excessive amounts of white cereals and sugar and little animal fat. These findings of Dr. Corry Mann also show that sunlight and other hygienic conditions are of minor importance, because the healthy and the rickety children lived under practically identical conditions except for a difference in feeding.

On reviewing the information from every quarter as to the nature of rickets-producing diets it would appear that excess of carbohydrate is practically as constant a feature as lack of animal fats. Moreover, the carbohydrate is always in the form of white cereals, malted foods, or sugar and the diet as a whole is therefore lacking in vitamin-B. Dr. Corry Mann has particularly emphasised the need for cutting off this excess of carbohydrate as the first step in treatment, instead of still further overloading the diet with milk and cod liver oil. The typical rickets-producing diet is represented in fig. 4 as lacking in vitamins A and B, and containing an excess of sugar and starch. Dr. Hess, in America, was successful in bringing up babies without the development of any sign of rickets upon a diet containing relatively little

FIG. 4.



Too little vitamin-A in the food is the chief factor causing RICKETS. Excess of starch or sugar, and a shortage of vitamin-B are contributory factors.

vitamin-A, but most carefully balanced to contain no excess of carbohydrate and well provided with vitamins B and C.

Rickets most usually develops as a consequence of the faulty diet given after weaning but it is by no means uncommon in breast-fed children. In these cases it is the mother's diet which is at fault. She cannot produce good milk if her food is poor in fat-soluble vitamin and overloaded with carbohydrate. It is essential for the prevention of rickets that the nursing mother should choose fats which contain vitamin-A and carbohydrates which supply vitamin-B.

CHAPTER VI

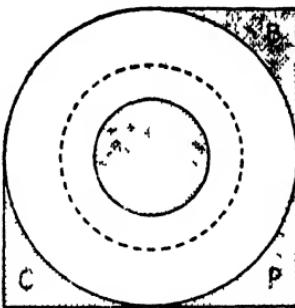
THE EYE DISEASE KNOWN AS KERATOMALACIA OR XEROPHTHALMIA

SCURVY is caused by the absence of vitamin-C and beri-beri by the absence of vitamin-B from the diet. Rickets is not exactly comparable with these two diseases as it is not caused by the absence of fat-soluble vitamin, but by a shortage of it in combination with other influences.

If the amount of fat-soluble vitamin in the diet is still further reduced, or absent, as shown in fig. 5, children do not develop rickets but suffer in other ways. Ricketty children are often abnormally fat and increasing in weight, but children getting practically no fat-soluble vitamin lose weight and become very wasted. There are no distinctive symptoms as in scurvy or beri-beri, but such children have an extraordinarily low resistance to any infection and are particularly liable to develop an inflammatory condition in the cornea of the eye, which if unchecked leads to blindness. Local

treatment of the eye has no effect, but the trouble is relieved in a few days by the addition of cod liver oil to the food. The sore eyes have occasionally been described amongst artificially fed infants in this country, but it is much more common in countries where nursing mothers practise long religious fasts. During the War there were many epidemics of this particular form of eye-disease, especially in Roumania, where the children

FIG. 5.



A diet without vitamin-A leads to FAILURE OF GROWTH, and lowered resistance to infections, especially of the eye and lung.

had no milk at all. Other outbreaks have been reported in Denmark and Japan. Everywhere cod liver oil was found to cure the disease and prevent blindness, if taken in time before the cornea was perforated. Animals on experimental diets lacking this vitamin suffer from a similar eye disease. Catarrh and infections of the digestive tract and lungs are common amongst this type of badly fed child or animal, and death results, not from any definite deficiency disease, but from some severe infection.

Adults appear to require less fat-soluble vitamin than the growing child but a deficiency of this vitamin is directly connected with a lowered resistance to infections, especially of the lung. In Central Europe, when the supply of animal fats was very limited as a result of the War there were outbreaks of a bone disease amongst adults. The sufferers had a peculiar waddling gait and the bones were painful to touch and sometimes fractured spontaneously, yet the disease was quite distinct from scurvy. X-ray examination showed an alteration in the structure of the bones. Cod liver oil, butter or animal margarine were all helpful in curing the disease though in very severe cases nothing but cod liver oil was of benefit. The disease must therefore have been caused by the absence of fat-soluble vitamin. This condition has never been reported in this country and has merely been quoted to emphasise the fact that people of all ages need fat-soluble vitamins.

CHAPTER VII

THE NEED FOR "GOOD" PROTEIN AND THE DISEASE, PELLAGRA

THE corner marked P stands for protein, a substance also concerned in the maintenance of health. The bodies of animals consist chiefly of protein; it cannot be built up from the fuel foods or from salts or water but only from protein. The foods which consist largely of protein are the lean of meat, fish, cheese, milk and eggs. Only small quantities of protein foods are required by the adult for the repair of his tissues, but the growing child needs relatively more as he has to form new body substance.

Protein has a very complicated chemical structure and is built up of some twenty different kinds of units, in themselves elaborate chemical substances. Each kind of protein may be compared with a chain, containing beads of some twenty different colours. During digestion the chain is broken and the beads separated and they pass into the blood stream. Each tissue or organ of the body has, as it were, a special protein pattern and collects only the kinds of beads which it wants to assemble this pattern. Animal proteins contain the beads in the most suitable proportions. Beads which do not fit into the patterns, or any excess of beads, are burned up as fuel. The Eskimos use protein and fat as their fuel food instead of carbohydrate, but in the milder climate of this country or in the tropics the use of protein as a fuel food is attended with certain dangers and is also a very expensive source of fuel.

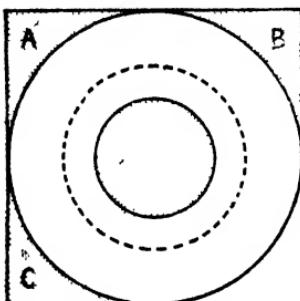
Plant proteins contain the same kinds of beads as animal proteins but in quite different proportions. Some kinds are present in excess and others may be very scarce or absent. In order to get enough of the kinds of beads which are scarce in plant proteins, an enormous amount of bulky vegetable food must be eaten and there is a great waste of the commoner kinds of beads, which are present in much larger quantities

than are needed. Sheep and cows have extra stomachs adapted for the working up of this mass of material so they can select the beads which they require, rejecting the others. By eating meat, or other animal protein, all the units or beads are supplied in suitable proportions. "Good" proteins are those which contain all the different kinds of beads. Most vegetarians take milk, cheese or eggs and so eat some animal food to obtain "good" protein.

In this country there is a liberal supply of animal protein but in some parts of the world, such as certain districts in Italy, in Roumania and in the Southern parts of the United States, large numbers of people have died from a peculiar disease called pellagra. This disease is characterised by digestive trouble and peculiar skin and mental symptoms, generally ending in insanity. In America this disease was increasing at an alarming rate and there were over 100,000 cases in the Southern States in 1916 and many more in 1917, but after that the disease began to decline owing to the measures taken to check it.

Those who believed in the dietetic origin of the disease at first thought it to be caused by maize, since it was chiefly confined to maize-eating districts, but it was more commonly believed to be infectious. However, Dr. J. Goldberger in the United States proved that pellagra develops if the food for a long period is poor in animal protein. A diet containing protein derived chiefly from seeds, such as maize or wheat, fails to supply all the necessary units or beads as we called them.

FIG. 6.



A diet without "good" protein leads to PELLAGRA.

In the Southern States where Goldberger carried out his investigations, there were no dairies or butchers' shops and very few people kept any cows, poultry or live stock. The inhabitants worked in cotton mills and lived almost entirely upon cereals, vegetables, syrup and fat bacon. In its earlier stages the disease could be cured by giving large amounts of animal protein. The absence of corner P from the "Square Meal" illustrates pellagra.

In Egypt pellagra broke out at the end of the War in camps for Armenian refugees and in camps for prisoners of war. The pellagra-producing diets were studied by Professor Wilson of Cairo. He found that the diet contained too little animal protein, although the total amount of protein in the diet satisfied the accepted physiological standard and there was no shortage of vitamins. The disease was cured by increasing the amount of animal protein. The quality of protein is the determining factor in the causation of pellagra. The accepted standard for the amount of protein failed in practice because it took no account of the separate protein units, or beads, but calculated the amount required solely from the nitrogenous value of the food. Every bead contains nitrogen so that the nitrogen content of the food is no index as to whether the protein is "good" or "bad." Wilson estimated that at least 40 grams ($1\frac{1}{2}$ ozs.) dry weight of animal protein must be taken daily in order to prevent the appearance of pellagra. Proteins derived from cereals, especially from maize, fail to supply enough of the rarer varieties of beads.

In contrast to the vitamins, protein is not harmed by heating, drying, or pickling. Tinned meat, dried or salted meat, fish or eggs, frozen meat, condensed milk, and other preserved protein foods supply just as "good" protein as the fresh material.

CHAPTER VIII

COMMON ERRORS IN OUR DIET

HAVING learned how the daily diet must be composed in order to fill each corner completely with the three vitamins and "good" protein, we are in a position to criticise the common every day diet.

In considering the provision of the daily food, it is first essential to look into the total quantities of the different foodstuffs consumed and to have some standard to work by. Under ordinary conditions of life it is impracticable to determine the exact quantity of each kind of food which is eaten. No one would care to have his dinner with his plate as the scale pan of a balance, though the method might be instructive and in these days of lovely spring balances with glass pans, considerable amusement might be afforded for a time in calculating out how nearly individual appetite corresponded with the actual physiological requirements.

Measurement is the basis of all science. The eye and the judgment are easily deceived but as soon as precise measurements are made one is dealing with facts and getting out of the realm of mere opinion. Chemistry was a hotch potch of ideas before 1774, when Lavoisier used the balance and showed us how oxygen was concerned in combustion.

The only method of ascertaining the average individual food consumption is from the daily household budget of quantities purchased and apportioning it according to the number of people. Even on this basis many allowances have to be made, since a pound of food purchased does not represent a pound of food eaten. Allowance must be made for the inedible waste, such as bone and skin in meat, shell of

eggs, outer leaves and peelings of vegetables and fruit. The allowance for such waste portions is difficult to estimate. Many tables have been compiled of the amount of waste matter in various foods. These are not much use to the ordinary householder, but are of great value to those who have to cater for large institutions, and for the Army and Navy.

Household food budgets have been carefully studied in Germany, the United States, and in certain towns of this country, especially in York by Rowntree for his book *Poverty*. From these various data we are able to set up an average standard of food consumption, which may be taken as—

<i>Protein.</i>	<i>Fat.</i>	<i>Carbohydrate.</i>
3½ to 4½	2 to 3	14 to 18 ozs. dry weight daily.

It is very interesting to know that these statistical figures of the average diet actually consumed correspond very closely with those found by exact physiological measurements on individuals who have been used as experimental subjects in the special form of apparatus called a calorimeter, by which every detail of intake and output of energy can be accurately measured.

From the data above certain valuable proportions can be calculated. Thus, taking the average protein as 4, fat as 3, and carbohydrate as 15, they total 22; so that protein is $\frac{4}{22}$, fat is $\frac{3}{22}$ and carbohydrate is $\frac{15}{22}$.

For simplification in making calculations these figures can be more conveniently expressed as :—

Protein $\frac{4}{22}$ or $\frac{1}{5}$; fat $\frac{3}{22}$ or $\frac{1}{7}$; and carbohydrate $\frac{15}{22}$ or $\frac{3}{4}$; that is, a typical diet consists of $\frac{1}{5}$ protein, $\frac{1}{7}$ fat and $\frac{3}{4}$ carbohydrate (dry weight).

It is not generally realised what a large proportion of the diet, $\frac{3}{4}$, consists of carbohydrate, which in these days is mainly white flour and sugar.

Some of the protein included in this proportion is plant protein derived from the vegetable food, and in order to represent the amount of "good" protein from animal foods like meat, fish or egg, this figure must be reduced by one-half. The protein ratio in the whole diet is thus subdivided into $\frac{1}{10}$ plant protein + $\frac{1}{10}$ animal or "good" protein.

These ratios may be compared with those of the constituents of cow's milk which is a "square meal" in itself for infants:—

<i>Protein.</i>	<i>Fat.</i>	<i>Carbohydrate.</i>	<i>Total.</i>
i.e., $\frac{3}{11}$	$\frac{3.5}{11}$	$\frac{4.5}{11}$	11 parts solid matter in milk.
or more conveniently—	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{2}$

The solid matter of milk thus consists approximately of one-quarter protein, one-quarter fat and one-half carbohydrate.

It shows that in changing from infant to adult food we reduce the proportion of protein from one-quarter to one-sixth and of fat from one-quarter to one-sixth and increase the amount of carbohydrate from one-half to two-thirds. This change is justified as the adult requires relatively more energy for work and less material for growth. In many cases the proportion of protein and fat are still further reduced by overloading the diet with carbohydrate, which, as has already been pointed out (p. 37) is a contributory factor in the development of rickets. During the whole period of growth the child's diet should approximate to the ratios found in milk, that is, it should contain more protein and fat and less carbohydrate than the adult diet.

Let us consider a specimen day's food for the adult, not of ideal composition, but such as might be consumed any day. It will be considered in the terms of the *dry weight* of protein, fat and carbohydrate contained in the most common foodstuffs.

The foodstuffs are especially differentiated into animal and vegetable sections added up separately to make it clear what proportion of the protein and fat are of animal origin and may therefore be considered as "good."

		Ozs. DRY WEIGHT.		
		Protein.	Fat.	Carbohydrate.
½-pint Milk (10 ozs.)	gives	1	—	—
One Egg (2 ozs.)	"	1	—	—
Meat, Fish (4 ozs.)	"	3	—	—
Meat-Fat, Butter	"	—	1 ½	—
Cheese (2 ozs.)	"	1	½	—
 Total from Animal Foods		1 ½	2 ½	½
Bread (8 ozs.)	gives	½	—	—
Potatoes (10 ozs.)	"	1	—	—
Cereals (Rice, Flour, Biscuits, Cake) (8 ozs.)	"	½	—	—
Sugar (2 ozs.)	"	—	—	—
Vegetables, Fruit, Jam, etc.	"	½	—	—
 Total from Vegetable Foods		1 ½	—	13 ½
 GRAND TOTAL (Dry Weight)		3	2 ½	14

All these figures are given on the moderate rather than the generous side. These amounts can easily be verified by taking the daily portions of these foodstuffs and weighing them, e.g., 10 ozs. of potatoes = two large boiled potatoes and is enough to supply vitamin-C.

The protein, fat and carbohydrate quantities add up to the total given before for the average figures compiled from statistics. A diet on the above scale satisfies the physiological requirements of the average individual as regards *quantity* of food.¹ The quantity as pointed out on p. 7 is varied according to the amount of work or exercise and the degree of exposure to cold and so 18 ozs. or more of carbohydrate may be eaten.

In referring now to the corners of "the Square Meal" to see if they are satisfactorily filled by the above ordinary diet, it is most convenient to consider first the "good" protein corner. These figures show that it is suitably filled by the average diet, which gives 3 ozs. dry weight, 1 ½ ozs. of it being animal protein (cf. Wilson's figure, p. 43). It is safe

¹See p. 61 for quantities contained in the ordinary foodstuffs.

to say that in this country the protein corner needs the least attention. Most people eat some meat, eggs, fish, cheese or drink some milk. It is possible that the very poor do not get quite enough, though some kinds of fish, tinned meat and condensed skimmed milk can be purchased at moderate prices and all supply "good" protein.

Although in the case of the poor the "good" protein may not come up to the $1\frac{1}{2}$ ozs. (dry weight) of this diet sheet there is evidence that smaller quantities of protein will suffice, as in Denmark during the War, when they were feeling the effect of our blockade. In general one may hazard that the amount of animal protein consumed by Europeans is larger than the actual physiological requirement.

The meat consumption per head of the population has increased greatly during the last fifty years. A first error in our diet will thus be a too large consumption of meat. This surplus of meat not only upsets the "squareness" of the day's food, but it has other consequences which lead to the overtaxing of the liver in its digestion and of the kidney in the excretion of its waste products. Although the total consumption of meat has increased in this country, at the same time gout, which is attributed to excessive meat-eating, has decreased. This is because the consumption of meat has become more general. Everybody eats some meat now-a-days. Fifty to a hundred years ago excessive amounts of meat were eaten by the richer classes and it was a luxury amongst the working classes. At the present time the only people who are in danger of a serious shortage of "good" protein (see fig. 6) are the very poor and a few people of eccentric dietetic habits. Amongst these two groups, the late Dr. Chas. Mercier reported cases of mental disease which were successfully treated by increasing the amount of meat in their food. It will be remembered that mental disease was one of the first and most serious signs of pellagra, the deficiency disease which is caused by a lack of "good" protein. Pellagra only occurs in this country under exceptional circumstances. The "good" protein corner is filled by the average individual's diet.

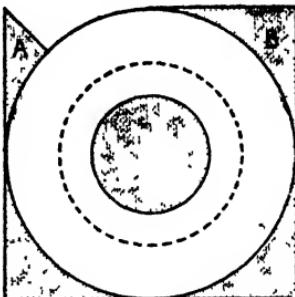
Where the income is small and the expensive protein foods like meat, fish, cheese, can only be purchased sparingly, it is very necessary to remember that the growing children have

first claim for this special body-building material. It is usually the men-folk, who, as chief wage earners, get these expensive foods and the children are given bread and jam or margarine. This is just the wrong way round. The bread and jam or margarine will supply a man with energy for hard manual labour but cannot help the child to grow. The nursing or expectant mother has also special needs for protein so that as a rule the man ought to be considered *last* where the supply of protein foods is limited.

Next to the "good" protein corner it is most logical to consider the A corner, because fat-soluble vitamins are supplied in meat fat. As far as the adult is concerned it is probable that he will get these vitamins in sufficient amount. All meats, eggs and green vegetables contain them, and assuming that the adult gets these foods he may safely eat margarine instead of butter. The position with children is different. The error here, as already seen, is over-loading with starch and sugar at the expense of all the other constituents of the food.

The shortage of fat-soluble vitamins, fig 7, is not confined to the children of the poor. Many children are the victims of over-fussy mothers and nurses. A number of natural sources of these vitamins are forbidden: meat, as "too stimulating," so the child gets no meat fat; eggs as "too binding" are only given occasionally. All fatty foods are considered "too rich," so white fish is given instead of oily fishes. The fish is boiled or steamed instead of being egg and bread-crumbed and fried in dripping or butter, the way the child prefers it. Bacon fat, which is lacking in fat-soluble vitamins is held in high esteem in the nursery and generally administered daily. Butter and jam are not allowed on the same piece of bread and the child prefers jam. There seems a conspiracy to deprive the nursery child of these vitamin-A foods. It fattens upon sweet and starchy food and is considered fine and well

FIG. 7.

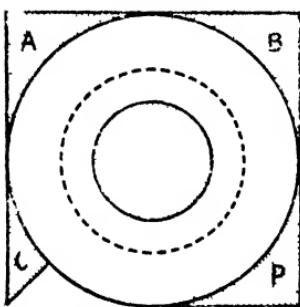


Shortage of vitamin-A.

nourished. It is inactive and late in walking and does not work off its fat by exercise. The flabby, fat type of child is proverbially "chesty." Like the experimental animals on the same kind of food, it is prone to lung infections. Remembering the special action of this vitamin in increasing resistance to infections, especially of the lung and eye, it is advisable to give plenty of foods rich in fat-soluble vitamins to those of all ages who suffer from catarrh or weak chests. The value of cod liver oil in the treatment of lung diseases has long been known. The great concentration of anti-rachitic vitamin in cod liver oil, makes it possible to give an abundance of this vitamin without overloading the diet with fat and risking digestive disturbance.

Closer attention is needed in considering possible errors in connection with the C corner of "the Square Meal." This vitamin is only contained in certain foodstuffs, often of low fuel value, so that they may easily be omitted. The diet sheet suggests 10 ozs. of potato and if this amount is taken, there is little fear of scurvy even in the absence of other fresh fruits and vegetables (see p. 17). The chances are that this amount of potato may not be consumed and then in the absence of fresh fruit or salad we are going on the road towards scurvy.

FIG. 8.



Shortage of vitamin-C.

There is much evidence that potato is the only antiscorbutic food eaten by many people amongst the poorer classes. Many of them are quite content to have no fresh fruit or green vegetables and greatly prefer pickles or sauces as a relish with their meat. Scurvy invariably appears after a failure of the potato crop. As recently as 1917 in Manchester, Newcastle and Glasgow, outbreaks of scurvy followed the failure of the potato supply.

In schools, institutions and boarding houses in which the catering is done as economically as possible, there is a tendency to omit fresh fruits and salads as they are considered unnecessary luxuries. A daily dish of prunes or figs is believed

to take the place of fresh fruits, and beetroot or pickles are served instead of green salad. Beetroot is no use as an antiscorbutic. The value of the green vegetables provided may be spoiled by over-cooking or the use of soda. Fruit is stewed or of the bottled or tinned variety. Amongst a large number of people there is thus only a slight margin of safety during the winter months.

Professor Sir Gowland Hopkins traced a period of ill-health in a boys' preparatory school to a lack of fresh fruits and vegetables during the winter months. Good health was restored by increasing the quantity of these fresh foods. The prevalence of influenza and other infectious diseases in the first three months of the year is well known. We malign our climate and put down all our winter ills to its vagaries, but the prevalence of infectious diseases in the early spring may be largely due to a smaller consumption of fresh fruits and vegetables during the winter months. At this season home-grown fruits are non-existent and home-grown vegetables scarce. During the virulent influenza epidemic which followed the War, it was observed that allotment holders who were provided with plenty of fresh-cut green vegetables suffered less from the disease. Oranges and lemons are so plentiful during the winter that no one need suffer from a shortage of this vitamin. One-third of an orange (1 oz.) a day is really enough. A Jaffa orange weighs with its skin 6 to 8 ozs. and without the skin 4 to 5 ozs.

The food provided at restaurants is nearly always very poor in vitamin-C and indeed it is not always easy to select a "Square Meal" from the varied bill of fare. The food is sometimes cooked at a central kitchen and distributed to branch depôts all over London. It is re-heated and perhaps kept simmering for hours till all the vitamin-C is destroyed. Appetising fresh fruits are not conspicuous articles at the cheaper restaurants. Fruit salad is a popular dish but is generally made from preserved fruits. "Home-made" lemonade sounds good but on investigation may prove to be a sickly-sweet artificial concoction with a fragment of a slice of lemon on top to give local colour.

There are no particular warning signs of a shortage of vitamin-C so it is difficult to form any judgment when the danger point is approaching. Perhaps the earliest sign is a

change in the complexion. The skin becomes sallow and muddy. There is a loss of vigour and of the sense of well-being, fatigue is felt after slight exertion. Fleeting pains in the limbs and joints may be mistaken for rheumatism. Another sign is the lowered resistance to infection and the slow healing of any wound. During the War wounds would not heal when the men were on the border-line of scurvy.

As a general conclusion about the C corner, it must be considered that certain classes of people are going short of this vitamin. It is essential that everyone should see that his food contains some fresh fruit or green salad every day. It would be a good plan to start the day with fruit at breakfast, like the Americans do. At tea-time, instead of jam, it is better to serve tomato, cress or lettuce sandwiches. It is only a question of forming the habit. If the money that is spent on sweets were spent on fresh uncooked fruit, how much healthier everyone would be.

The remaining corner B, though taken last, is the predominating corner of the whole scheme. Like the Queen in a game of chess, it commands all the other pieces. The amounts of vitamin-B required (p. 26) were expressed in percentages of the total food because this vitamin must bear a constant relation to the quantity of food eaten. The amount required cannot be expressed in terms of a daily dose. *The more food eaten the more vitamin-B required.* It is a question of balance. The consumption of foods like fat, sugar or white flour upsets the balance as they contain no vitamin-B. It is the consumption of fuel foods unbalanced by vitamin-B which leads to beri-beri. To prove the delicacy of this balance of vitamin-B and the fuel foods, some old experiments of Braddon and Cooper, often overlooked, may be referred to. They fed birds upon a certain quantity of white rice and a certain quantity of yeast, say, x white rice + y yeast. On doubling the amount of rice and leaving the yeast the same, that is, $2x$ rice + y yeast, the birds developed beri-beri but were quite well on the smaller amount of rice, when the balance was x to y . Some of our own experiments have confirmed this and also showed that fat must be balanced by vitamin-B, if there is $2x$ of fat, y of yeast is not enough. If the amount of fat were increased without increasing the

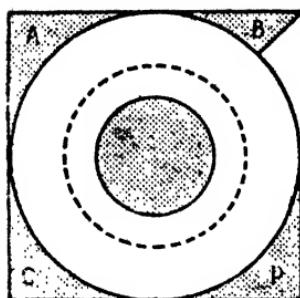
supply of vitamin-B, the birds got ill but recovered on giving more yeast extract which was used to supply vitamin-B. The fat used in this particular case was cod liver oil and this observation indicates that large amounts of cod liver oil should not be added to a child's diet unless the vitamin-B is increased proportionately. It has also been found that if the protein in the food is increased from x to $2x$, then the yeast must be increased from y to $2y$. It is possible to express this relationship as $\frac{\text{vitamin-B}}{\text{total food}} = \text{a constant.}$

This ratio expresses the fact that the more food is eaten the more vitamin-B is required to keep the constant. Suppose that vitamin-B is 1, and the total food is 10; if the total food is increased to 20, the vitamin-B must be increased to 2, or the constant would become one-half of what it was, that is, it would cease to be a constant.

This balance has an important application in the feeding of children, who do not easily digest fat. If these children be given vitamin-B in the form of yeast extract, their powers of digesting and assimilating fat are improved, and they are able to take egg or cod liver oil, which previously upset them.

Our typical day's diet (p. 47) may now be referred to bearing these points in mind. Milk, eggs, potatoes and perhaps cheese are the only foods containing vitamin-B. Of these milk and cheese together contain enough to balance their own fuel value but do not contain any excess to compensate for foods which contain none of this vitamin. Potatoes contain a slight excess; white bread and sugar contain none. *The question is whether the foods that have vitamin-B contain enough of it to balance the foods which have none.* The answer is decidedly NO. The eggs may balance the butter, and the potatoes compensate for the small allowance of sugar, 2 ozs. There is little doubt that the white bread, white flour and other white cereals in puddings and cakes are unbalanced. If more sugar be eaten, which is very likely, then the conditions are still worse. The corner B is not filled (fig. 9) and it is quite a typical diet. Unless unusually large quantities of eggs, pulses, internal organs such as liver, that is, the vitamin-B foods are eaten, the white bread, flour, cereals and sugar are not compensated for.

FIG. 9.



Shortage of vitamin-B.

in the seeds of plants and if the germ and bran are removed from our staple cereals by the milling, the vitamin-B is removed and its loss can only be compensated for by the addition of some specially concentrated vitamin-B food such as yeast extract (marmite). The amount of yeast used in ordinary bread, about two per cent., is too small to be of any account. The figures show that ten per cent. of yeast extract, which is much stronger than bakers' yeast, is necessary for pigeons.

It may be of interest to study the diet which failed to prevent beri-beri amongst our troops in the Dardanelles. The daily allowance for each man was as follows:—

			lbs. ozs.	
White Bread	-	-	2 0	
Rice	-	-	0 4	
Sugar	-	-	0 2	
Margarine or Butter	-	-	0 2	
				2 lbs. 8 ozs. of foods which do not contain vitamin-B.
Meat or Bacon	-	-	0 6	
Cheese	-	-	0 2	
				8 ozs. of foods balanced by their own vitamin-B.
Peas, Beans or Lentils	-	0	0 to 4	
Potatoes or fresh Vegetables	-	0	2	
				2 to 6 ozs. of foods rich in vitamin-B.

This diet is not unlike that of the working classes at home except for the absence of eggs and a shortage of potatoes and other vegetables. It is therefore probable that it is eggs and potatoes which are the chief safeguards in this country against the appearance of the paralysis seen in advanced beri-beri. In winter, when eggs are dear and

FOOD AND HEALTH

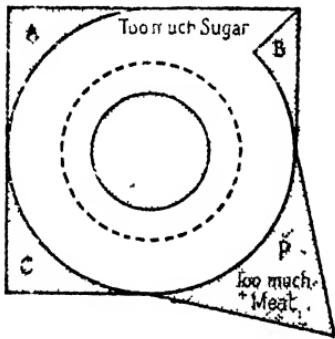
scarce, potatoes are the one redeeming feature in the of the poorer classes for vitamin-B as well as for vitamin-. The majority of the people are living on the kind of diet which in experimental animals just prevents the appearance of paralysis typical of advanced beri-beri, or which delays the appearance of these symptoms for a very long time. Before the advanced signs of beri-beri develop in these animals, they first suffer from constipation and may die from colitis or appendicitis. Constipation, appendicitis and colitis are common every day ailments which we try and avoid or relieve with pills. It has even been asserted that cancer comes from a primary condition of indigestion and constipation and J. Ellis Barker, in his book *Cancer*, has amassed a vast amount of evidence in support of this view. The statistics show that cancer and diabetes are increasing all the world over and so is the consumption of starch and white sugar. It would appear that it is the starch and sugar diet with its shortage of vitamin-B which is responsible for the preliminary troubles which culminate in cancer and diabetes. Yet we put up beet sugar factories in this country assisted by the Government !

The term *shortage* is used in contradistinction to the terms *deficiency* or *absence*. By deficiency we mean the practically complete absence of the vitamin which in a few months causes the definite appearance of the paralysis symptoms of beri-beri which, if taken in time, can be cured with almost miraculous speed by the addition of foods rich in vitamin-B. Pigeons, developing paralysis symptoms in three weeks, will recover within twenty-four hours after being given a dose of marmite or other substance rich in vitamin-B. If the birds are a long time getting ill, that is, become chronic sufferers from constipation and its consequences, it is never possible to get them well again however much vitamin-B is given. In these slow chronic cases the damage done to the digestive tract has gone too far to be repaired. In the same way people who have lived largely on white bread and sugar for thirty or forty years cannot hope by a change of food to get their digestive tract to work normally. All that can be done is to give a certain measure of relief and to stave

off worse consequences. It is the next generation who must be prevented from suffering in the same way.

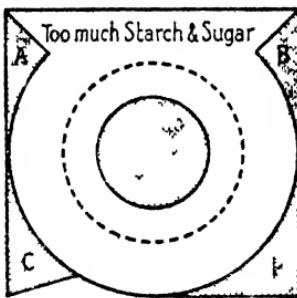
The common errors of our diet are illustrated by means of distortions of "the Square Meal." In the case of the poorer classes there is probably a shortage of all three vitamins with excess of flour and sugar. In the very poor there may be a slight shortage of protein. In the richer classes there is a shortage of vitamin-B and an excess of protein and animal fat, with a sufficiency of vitamin-C. The richer classes eat animal protein for breakfast, lunch and dinner. They have many things made with white flour, cereals and sugar and generally eat chocolates and sweets, so that the B corner is not filled. The poor man's diet is seen to resemble that of rickets (p. 38). All three pictures have one common feature, a shortage of vitamin-B and excess of starch and sugar. The diets of the rich and poor are illustrated in figs. 10 and 11.

FIG. 10.



The diet of the RICHER CLASSES contains too much sugar and meat, and too little vitamin-B.

FIG. 11.



The diet of the POORER CLASSES contains too much starch and sugar, and too little of all the vitamins, especially of A and B.

The diet of the nursing mother needs a little consideration on account of certain superstitions. She may be cut off green vegetables because they are supposed to give the baby wind. Orange juice taken by the mother is said to curdle her milk. If she eats cheese it is also supposed to upset the baby. The mother is kept on a nice white diet and she has a white-faced,

constipated nursing. It is a common belief that any breast-fed infant is receiving ideal food and cannot possibly suffer from malnutrition. This is only the case if the mother's diet is good. If her food consists chiefly of white flour and sugar with little fruit and vegetables, the child will inevitably suffer. Rickets is not rare in breast-fed children (p. 38), and in the East there is a large mortality from infantile beri-beri in breast-fed infants whose mothers live chiefly on white rice. We know that the amount of vitamins in cow's milk depends on the food of the cow. Of all people the nursing or expectant mother most especially requires good food as she has two to feed. It may be said that her meals require to be more than square, each corner should be almost doubled. This does not mean that she should try and eat twice as much food but that she should eat more of the special vitamin foods (see frontispiece) and a little more protein.

In planning the daily food it is not always possible to make each meal "a square" one. At any rate the food for the whole day must be square, that is, contain suitable proportions of the foods from each of the four corner lists (see frontispiece).

It is not enough just to provide good food. It is necessary to see that it is fairly divided and actually eaten. From time to time cases of pellagra, beri-beri and scurvy have cropped up in institutions in which the diet was well planned. Investigation traced the occurrence of the disease to individual fads and the habitual refusal of certain articles of food. For instance, in schools green vegetables are provided, but how many children will eat them if left to their own devices? Other children dislike fat and have a perverse craving for sugar. The pernickety adult is generally a miserable dyspeptic.

Civilisation has made it too easy to get wrong foods of all kinds and difficult to get the foods we ought to eat. Natural foodstuffs form but a small part of the present-day diet, because they have for convenience been replaced by less perishable foods. As we walk down any London street we are continually being tempted by displays of groceries, sweets and cakes. Whole shop-fronts are dressed artistically with all the foods we should not eat.

The child is offered an overwhelming choice of artificial products. It early acquires a taste for sugar and yet more sugar and turns against butter and green stuff as flavourless. It is not a kindness to children to over-indulge them with sweets. The figures for the Board of Trade show that the imports of sugar have increased enormously per head of the population, thirty times as much sugar is used per head now as compared with a hundred years ago. Sugar, in its concentrated form, is not a natural food. At one time honey in very limited quantities was the only sweetening agent available. Sugar forms no part of the diet of the Indian hill tribe of the State of Hunza, whom Colonel McCarrison describes as living on natural foods and having the perfection of health and physique.

The virtues of brown bread have been extolled but brown sugar is no better than white. Sugar should be taken in its natural forms as contained in fruits and vegetables. The craving for sugar is an unhealthy taste as dangerous in its effects as a craving for alcohol or drugs. A liking for salt food and pickles are other forms of depraved taste and those who require to have their appetites tempted by sugar, salt or vinegar, invariably dislike the plain foods which supply the corners to "the Square Meal."

A very varied and "tasty" diet may contain little or none of the vitamins, providing only fuel and the corner P. On the other hand, very monotonous diets may contain all the essentials, such as milk and potatoes, upon which the Irish peasant thrived and produced children free from rickets. During the War the Danish people had to exist upon very plain fare which yet supplied everything necessary. Meat was unobtainable except by the very wealthy, and the rest of the people lived upon

- Bread, made of Whole Rye, Wheat Bran and Barley.
- Barley Porridge.
- Milk, in considerable quantities.
- Butter.
- Greens.
- Potatoes.

A terrible outcry would arise if the British working man were given such plain fare, yet it is physiologically an excellent diet. During the period of its consumption the death rate in Denmark fell by 34 per cent., and fewer new cases of cancer

were notified. Hindhede, a Danish physiologist, concluded from this experience that "the principal cause of death lies in food and drink."

To summarise the position in this country, it may be said that we do not suffer from any one of the so-called deficiency diseases—scurvy, beri-beri, or pellagra—except in rare instances, but that the health of the nation does suffer very severely from the effects of a chronic slight shortage of one or more of the vitamins. Without being entirely lacking in any one vitamin, our food does not contain enough of them to fill each "corner" completely. Such a condition is inconsistent with health and if we are to produce an A1 stock everyone must eat "square meals," give up white starchy foods and sugar and cut down the amount of meat, if necessary, eating instead wholemeal bread, fruit, vegetables, milk products and eggs.

TABLE SHOWING EFFECT OF HEAT, AND
PRESERVATION PROCESSES, ON VITAMINS

A complication about vitamins is that treatment with heat, chemicals, drying and other processes, have different effects for each of the three vitamins. For convenience of reference the effect of these agents has been tabulated.

<i>Agent.</i>	<i>Vitamin-A.</i>	<i>Vitamin-B.</i>	<i>Vitamin-C.</i>
Drying—			
(a) Exposed to air	Destroyed.	Not destroyed.	Destroyed.
(b) In a vacuum	- Not destroyed.	Not destroyed.	Not destroyed in certain cases
Heating—			
(a) Exposed to air (i.e. cooking)	Gradually destroyed.	Not destroyed.	Gradually destroyed.
(b) In a vacuum	- Not destroyed.	Not destroyed.	Destroyed except in certain cases.
(c) In a closed vessel (pasteurisation)	Not destroyed.	Not destroyed.	Slowly destroyed.
(d) Under pressure (sterilisation)	- Not destroyed.	Destroyed.	Destroyed.
Soda or Alkali	- Not destroyed.	Destroyed.	Destroyed.
Ageing	- Slowly destroyed.	Slowly destroyed.	Quickly destroyed.
Preserving—			
(a) Tinned Meat	- Not destroyed.	Destroyed.	Destroyed.
(b) Bottled Vegetables and Fruits	- Not destroyed.	Reduced.	Destroyed.
(c) Pickled Eggs	- Not destroyed.	Not destroyed.	—
(d) Frozen Meat, Butter	- Not destroyed.	Not destroyed.	—
(e) Fruit	- Not destroyed.	Not destroyed.	Slowly destroyed.
Milling of Cereals to make White Flour, Rice, etc.	- Removed.	Removed.	—

QUANTITY (DRY WEIGHT) OF PROTEIN, FAT, AND CARBOHYDRATE CONTAINED IN THE ORDINARY FOODSTUFFS

An average day's food (p. 45) consists of

Protein		Fat	Carbohydrate
Animal	Vegetable		
1/2	1/2	1/2	1/2 of total dry weight.
2 to 2.5	1.5 to 2.5	2 to 3	14 to 18 oz. dry weight.
3.5 to 5			

The following table has been compiled to show the amount of protein, fat and carbohydrate present in 1, 4, or 8 oz. of the common foodstuffs. It will thus be easier to check the actual consumption of each food constituent.

Animal Foods.				Vegetable Foods.			
	oz. Dry Weight of				oz. Dry Weight of		
	Protein.	Fat.	Carbo-hydrate		Protein.	Fat.	Carbo-hydrate
4 oz. of				4 oz. of			
Lean of Meat				Flour,			
(Beef, Mutton, Pork)	0.9	0.3	—	Rice, &c. ...	0.4	—	3.0
Poultry, Rabbit, Game	0.9	0.1	—	Oatmeal ...	0.5	0.3	2.8
Kidney, Heart	0.7	0.1	0.1	Bread ...	0.3	—	1.9
Liver ...	0.9	0.1	0.1	Biscuit (plain) ...	0.5	—	3.0
Tongue ...	0.5	1.1	—	Sago, Tapioca —	—	—	3.5
Bacon (Streaky)	0.4	2.2	—	Dried Peas,			
Sausage ...	0.4	0.7	0.6	Beans, Lentils 0.9	—	—	2.5
Cod & White Fish	0.7	—	—	8 oz. of			
Herring, or Mackerel, or Salmon	0.8	0.4	—	Potato ... 0.2	—	—	1.6
Eggs (2) ...	0.5	0.4	—	Cabbage,			
Cheese ...	1.0	1.3	—	Lettuce, &c. 0.1	—	—	0.4
Milk, 1 pint (20 oz.) ...	0.6	0.7	1.0	Carrots,			
1 oz. of				Roots, &c. 0.1	—	—	0.8
Butter, Margarine ...	—	0.8	—	Fresh Green Peas ... 0.3	—	—	0.7
Meat Fat, Suet	—	1.0	—	Apple, Orange, &c. —	—	—	0.8
				Banana ... 0.1	—	—	2.0
4 oz. of				Raisins,			
				Prunes, &c. 0.1	—	—	2.4
				Jam, Honey —	—	—	2.8
				Nuts ... 0.7	2.3	0.5	
				Cocoa ... 0.7	1.1	1.6	
				Chocolate ... 0.2	1.0	2.4	
				Sugar ... —	—	—	4.0

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